

APPENDIX I

HYDROLOGIC AND ECOLOGICAL MONITORING REPORT SUMMARY

Executive Summary

Test Iteration 7 Experimental Program of Water Deliveries To Everglades National Park Central and Southern Florida Project For Flood Control and Other Purposes

February 2001

**Prepared for:
Jacksonville District
Army Corps of Engineers
400 West Bay Street
Jacksonville, FL 32202**

**Prepared by:
Dial Cordy and Associates Inc.
490 Osceola Avenue
Jacksonville Beach, FL 32250**

TABLE OF CONTENTS

	Page
1.0 INTRODUCTION.....	1
2.0 WADING BIRD MONITORING AND RESEARCH REPORTS (1997-1999)	2
2.1 Introduction	2
2.2 Methodology.....	3
2.3 Results	4
2.4 Discussion.....	5
2.5 Summary.....	6
2.6 Literature Review	6
3.0 RESIDENT FISHES WITHIN THE MANGROVE ECOTONE (1997-1999).....	7
3.1 Introduction	7
3.2 Methods	7
3.3 Results	8
3.4 Discussion.....	9
3.5 Summary.....	11
3.6 References	11
4.0 FISH AND MACROINVERTEBRATE MONITORING (1997-1999)	13
4.1 Introduction	13
4.2 Methodology.....	13
4.3 Results	14
4.4 Discussion.....	15
4.5 Summary.....	16
4.6 Literature Cited.....	16
5.0 AMERICAN CROCODILE MONITORING (1997-1999)	18
5.1 Introduction	18
5.2 Methodology.....	18
5.3 Results	19
5.4 Discussion.....	19
5.5 Summary.....	20
5.6 Literature Review	20

6.0 CAPE SABLE SEASIDE SPARROW (1997-1999)	22
6.1 Introduction	22
6.2 Methodology.....	22
6.3 Results	23
6.4 Discussion.....	23
6.5 Summary.....	24
6.6 Literature Cited.....	25

APPENDIX A Test 7 Program Monitoring Program Agreement

APPENDIX B Test 7 Iteration Years One through Four Hydrologic Monitoring Report

1.0 INTRODUCTION

A monitoring plan for Test 7 of the Experimental Program of Water Deliveries to Everglades National Park (Experimental Program), as specified in item 4 of the October 5, 1995 Concurrency Agreement was developed to assess ecological responses during the period of Test 7, and to establish ecological baselines for future iterations of the Experimental Program (Appendix A). The geographical area of coverage for this monitoring program included all portions of the southern Everglades region predicted to be affected by the Experimental Program. The monitoring elements included in the Jacksonville District, USACE responsibilities were freshwater fish and macroinvertebrates, wading bird colonies, Cape Sable seaside sparrows, American crocodile, resident fishes within the mangrove ecotone, and hydrology.

Except for the hydrologic component, the complete monitoring reports for these elements have previously been compiled and distributed for review. This document merely summarizes the findings of the yearly reports and serves as an Executive Summary for the monitoring effort. The complete four year hydrologic monitoring report is included as Appendix B of this document.

2.0 WADING BIRD MONITORING AND RESEARCH REPORTS (1997-1999)

2.1 Introduction

The U.S. Army Corps of Engineers (ACOE) is proposing several projects to restore a more natural hydrology regime to the ecosystems within Everglades National Park (ENP). In order to complete the restoration projects, several tests have been completed to assess the effectiveness of these projects. The most recent test monitored the restoration efforts from the years 1997-1999, known as the Test 7 Iteration. One aspect of the monitoring involves the direct and indirect effects these projects may have on wildlife species and their habitat. The U.S. Fish and Wildlife Service (USFWS), in their Biological Opinion for this project, has cited several species that potentially may be impacted by these projects (USFWS 1999). One group of wildlife species that may be impacted is wading birds. A monitoring program was initiated in 1997 in order to assess the potential impact of the Everglades restoration projects on wading birds.

The original Everglades marsh ecosystem provided abundant primary and secondary production during the wet summer and fall months (Holling et al. 1994), and this productivity was concentrated during the dry winter and spring when water levels receded. The concentrations of food provided ideal foraging habitats for numerous wetland species, especially large flocks of wading birds (Ogden 1994, Bancroft 1989). However, the hydrology of the Everglades has been severely altered by extensive draining and the construction of canals and levees (Light and Dineen 1994). The resulting system is not only spatially smaller, but also drier than historical levels (Walters et al. 1992). Moreover, the timing and distribution of water flow have been highly altered.

Breeding populations of wading birds have responded negatively to altered hydrology (Ogden 1994, Bancroft 1989, Kushlan and Fohring 1986). As a result, numbers of breeding wading birds in the Everglades have decreased by more than 90%. During favorable years in the 1930's, up to 250,000 wading birds, including white ibises (*Eudocimus albus*), wood storks (*Mycteria americana*), great egrets (*Casmerodius albus*), snowy egrets (*Egretta thula*), and tricolored herons (*E. tricolor*) nested in the central and southern Everglades (Ogden 1994). Maximum numbers had decreased to 54,000 by the 1970's and further to 22,000 by the 1980's (Ogden 1994). During the 1930's approximately 90% of the wading birds nested along the interfaces between the freshwater Everglades and the mangrove-estuaries (Ogden 1994). By the 1980's, the majority of nesting wading birds had shifted to nesting in the interior freshwater Everglades, principally in the Water Conservation Area (WCA) (Ogden 1994). These changes were presumably the result of extensive hydrological alterations (water flow and volume) in the Everglades system (Ogden 1994, Bancroft 1989).

Significant declines in the number of wading birds have contributed to the movement toward restoring the hydrologic conditions of the Everglades to more historic patterns. The South

Florida Water Management District (SFWMD) and the ACOE are currently evaluating and implementing water requirements that would restore the WCA and ENP in ways that would improve the natural conditions of the Florida Everglades. Restoring the Everglades could help to improve conditions for wading birds.

2.2 Methodology

The number and distribution of foraging wading birds was estimated using a systematic aerial transect method (Norton-Griffiths 1978) as modified by the National Audubon Society (Bancroft and Sawicki 1995). Systematic reconnaissance flights (SRF) were flown in areas consisting of east-west transects spaced at 2 km intervals. These systematic transects were flown in three main areas; the WCA's, the Holey Land, and the Everglades Nutrient Removal Area (ENR). The monthly flights occurred between January and June in 1997 and 1998, and February through July in 1999. Transects were flown in a Cessna 182 at 61 m (200 ft) altitude and a ground speed of 145-185 km/h. Two observers, one on each side of the airplane recorded all wading birds observed within 150 m wide strips paralleling the plane's path. When birds were sighted in the strips, the longitude was recorded from a Global Positioning System (GPS) receiver. The species, number, behavior, and longitude were recorded for all sightings within the strips. Birds identified to species included the great blue heron (*Ardea herodias herodias*), great egret, white ibis, glossy ibis (*Plegadis facinellus*), and wood stork. The tricolor heron and little blue heron (*Egretta caerulea*) were identified as "small dark herons" because of the difficulty of distinguishing the two bird species in a large mixed flock. Snowy egrets and first-year little blue herons that could not be correctly identified were classified into a group called "small white herons" (Bancroft and Sawicki 1995). Small white herons and small dark herons were then grouped together into a third category called "small herons". A third category, "others", was included to represent the roseate spoonbill (*Ajaia ajaja*), great white heron (*Ardea herodias*), and the cattle egret (*Bubulcus ibis*).

During the surveys, surface water coverage was recorded. Bancroft and Sawicki (1995) classified water coverage into four categories; (1) wet conditions were defined as having water completely covering the ground surface, (2) wet transitional conditions had partially exposed ground, but more than 50% of the ground surface flooded, (3) dry transitional conditions for areas less than 50% flooded, and (4) dry conditions where surface water appeared only in ponds, canals, and alligator holes. These water conditions were recorded on a broad scale, such that each 2-km x 2-km cell was assigned a single value in a given month. The water data recorded during the surveys was coded numerically and transferred to computer files for mapping.

2.3 Results

1997 Survey

Comparisons of a respective species/species group mean monthly estimated abundance in 1997 with the overall mean monthly estimated abundance for the 11 earlier years (January to June, 1985-1995) indicated that great egrets and glossy ibises monthly mean in 1997 were slightly higher than the 11-year mean; great blue herons, white ibises, wood storks and small herons in 1997 were much lower than the 11-year means.

A pattern of rising water levels was observed throughout the summer to a maximum in the fall then a decline until the end of spring during 1996-1997, a pattern also reported in previous years (Bancroft and Sawicki 1995). The range of water levels varied little during each month of the six month survey season. Mean monthly water levels and the percent of cells fell within the wet category for each month of the survey period. Based on water levels and percent wet cells, 1997 survey periods were categorized as wet conditions.

1998 Survey

Comparison of a respective species/species group mean monthly estimated abundance in 1998 with the overall mean monthly estimated abundance for the 11 earlier years (January to June 1985-1995) indicated that monthly estimated abundance in 1998 was much lower than the 11-year monthly mean for all wading bird species except the white ibis and great egret. Both of these species exhibited monthly estimated abundance that were close to their respective 11-year mean during any month.

A pattern of rising water levels was observed throughout the summer to a maximum in the fall then remained high through March 1998 when water levels declined until the end of spring (June 1998). The range of water levels varied little during each month of the six-month season. Mean monthly water levels and the percent of wet cells fell within the wet category for each month of the survey period. The monthly percent of wet cells ranged from 83% (June) to 100% (January) for 1998. The percent of wet cells was 100% from January to March for 1998. Based on water levels and percent wet cells the 1998 survey period was categorized as very wet for January to March then dried rapidly.

1999 Survey

The mean monthly estimated abundance in 1999 were much higher than 1998 for all species except the great blue heron. The mean monthly estimated abundance was used as an index of long-term trends to compare each respective species/species group mean monthly estimated abundance in 1999 with the overall means monthly estimated abundance for 11 earlier years (January to Jun 1989-1999). The respective species/species group mean monthly estimated

abundance in 1999 with the overall mean monthly estimated for the 11 earlier years indicated that monthly estimated abundance's in 1999 for all species was lower than the 11-year monthly mean. The monthly estimated abundance for the white ibis and great egret were close to their respective 11-year mean during any month.

Rising water levels were observed through fall of 1998, then declined until spring, 1999. The monthly range of water levels (minimum fluctuation) was small during February to May of the survey. Mean monthly water levels and the percent of wet cells fell within the wet category February to May of the survey period. The monthly percent of wet cells declined from 100% (February) to 53% (May). The reduction in water levels was reflected in an increase in the number of wading birds February through May and then a rapid decline in wading bird numbers coincident with increasing water levels and variability of water levels during June and July, 1999.

2.4 Discussion

The typical annual pattern of rising water levels throughout the summer to a maximum in the fall, followed by a decline until the end of spring (Bancroft and Sawicki 1995), occurred during the Test 7 Iteration, 1997-1999. In 1998, water levels were much higher than the other two years of the study and subsequently, there were fewer numbers of wading birds. The water level in the study area seems to influence wading bird populations since reduced water levels concentrate prey and allows water depths that can be more easily waded by these birds.

The amount of surface water coverage seemed to influence the wading bird populations. Higher wading birds populations were observed during 1997 and 1999, when the surface water coverage between January and July was categorized as wet. Wading bird observations were lower in 1998, when conditions were categorized as very wet, which parallel the reduced wading bird populations of 1995, when similar conditions existed (Sawicki et al. 1995).

Using the mean monthly estimated abundance as an index of long-term trends, each respective species/species group mean monthly estimated abundance for 1997-1999 were compared with the overall mean monthly estimated abundance for the 11 earlier years (January to June, 1985-1995). In 1997, only great egrets and glossy ibises were higher than the 11-year monthly mean. The comparisons of a respective species/species group mean monthly estimated abundance in 1998 with the overall mean monthly estimated abundance for the 11 earlier years indicated that monthly estimated abundance in 1998 for all species, except for the white ibis and great egret which were close to the average, was much lower than the 11-year monthly mean. In 1999, comparison of a respective species/species group mean monthly estimated abundance with the overall than monthly estimated abundance for the 11 earlier years indicated that monthly estimated abundance in 1999 for all species was lower than the 11-year monthly mean.

2.5 Summary

Differences in wading bird populations were observed during the three year study period throughout the study area. Population differences were primarily caused by water level fluctuations, which may affect prey capture efficiency. These year to year differences demonstrate how wading birds respond in successive years to changing water levels (Nelson and Theriot 1999). Mean monthly variations for each species varied at times for each year of the study. Compared to the previous 11 earlier years, overall mean monthly estimated abundances showed a general decrease during this study. These differences may be a result of wading birds responding to temporary impacts due to water fluctuations, or may be some other factor not seen by such a short-term study. Any fluctuations evidenced from this three year study should be tempered with caution, since only consistent long-term studies of endangered species will reveal trends versus short-term fluctuations.

2.6 Literature Review

- Bancroft, G. T. 1989. Status and conservation of wading birds in the Everglades. *American Birds* 43: 1258-1256.
- Bancroft, G. T. and R. J. Sawicki. 1995. The distribution and abundance of wading birds relative to hydrologic patterns in the Water Conservation Areas of the Everglades: Final Report. National Audubon Society, Tavernier, FL.
- Holling, C. S., L. H. Gunderson, and C. J. Walter. 1994. The structure and dynamics of the Everglades system: Guidelines for ecosystem restoration. Pages 741-756 in S. M. Davis and J. C. Ogden (eds.). *Everglades: The ecosystem and its restoration*. St. Lucie Press, Delray Beach, FL.
- Kushlan, J. A., and P. D. Fohring. 1986. The history of the southern Florida wood stork population. *Wilson Bulletin* 98:368-386.
- Light, S. S. and J. W. Dineen. 1994. Water control in the Everglades: A historical perspective. Pages 474-483 in S. M. Davis and J. C. Ogden (eds.). *Everglades: The ecosystem and its restoration*. St. Lucie Press, Delray Beach, FL.
- Norton-Griffiths, M. 1978. Counting animals, Handbook No. 1. African Wildlife Leadership Foundation, Nairobi, Kenya.
- Ogden, J.C. 1994. A comparison of wading bird density colony dynamics (1931-1946 and 1974-1989) as an indication of ecosystem conditions in the southern Everglades. Pages 533-570 in S. M. Davis and J. C. Ogden (eds.). *Everglades: The ecosystem and its restoration*. St. Lucie Press, Delray Beach, FL.
- Walters, C., L. Gunderson, and C. S. Holling. 1992. Experimental policies for water management in the Everglades. *Ecol. Appl.* 2:189-202.

3.0 RESIDENT FISHES WITHIN THE MANGROVE ECOTONE (1997-1999)

3.1 Introduction

The U.S. Army Corps of Engineers (ACOE) is proposing several projects to restore a more natural hydrology regime to the ecosystems within Everglades National Park (ENP). In order to complete the restoration projects, several tests have been completed to assess the effectiveness of these projects. The most recent test monitored the restoration efforts from the years 1997-1999, known as the Test 7 Iteration (Test 7). Test 7 was designed to increase water deliveries to Taylor Slough and increase wet season water storage in the southern Everglades. These increases were expected to increase fresh water flow to the mangrove zone, which in turn was expected to decrease salinity and increase hydroperiod in these areas. The change in these physical conditions was expected to have a positive impact on biological productivity.

The focus of the monitoring program was to evaluate the impacts of Test 7 on the biota of the mainland coastal mangrove wetlands located between Florida Bay and the fresh water systems of Taylor Slough and the C-111 basin. A cooperative agreement between ENP and the National Audubon Society (NAS) established the following four *****objectives for the monitoring program:

Objective 1: Monitor fish abundance and diversity at historical NAS sampling locations in mainland coastal wetlands and correlate fish abundance and diversity with hydropatterns and hydrography.

Objective 2: Monitor community structure and abundance of submerged aquatic macrophytes in the creek systems associated with four NAS sampling locations in relation to hydropatterns and fish community structure.

Objective 3: Examine the biology of the Mayan cichlid (*Cichlasoma urophthalmus*) and evaluate its impact on the native fish community.

3.2 Methods

Objective 1

In addition to data provided by nearby ENP hydrostations, water levels were continuously monitored at each sampling site using a Telog 2108 potentiometric recorder. Salinity was measured at each site on the day of fish collections using an optical refractometer. Fish collections were conducted with a 9 m² drop net placed around a dwarf mangrove. Nine nets were deployed at each sampling site. Three nets were placed around mangroves in each of the

following three microhabitats: creek, creek-flats interface, and flats. Nets were suspended above the dwarf mangroves and left overnight for deployment the following morning. Nets were triggered 1-2.5 hours after sunrise. The area inside the net was treated with rotenone, and the dead and dying fish were collected. The potential for rotenone effects outside the net was avoided by surrounding the net with water-proof material and neutralizing the rotenone with potassium permanganate at the end of each collection event. Fish collections were analyzed in relation to rainfall, water level, and salinity patterns. Results from each of the years comprising the monitoring period 1996-97, 1997-98, and 1998-99) were compared with data from pre-Test 7 years that had similar rainfall (1993-94, 1994-95, and 1992-93, respectively).

Objective 2

Submerged aquatic vegetation (SAV) surveys were conducted at locations associated with the four fish sampling sites. The point intercept percent cover method was used to determine species composition and abundance. At least 12 randomly located 0.25 m² quadrats were sampled at each location. The percent cover for each species and total coverage of all species were determined for each quadrat. Similar surveys were conducted along creek transects extending downstream from the fish sampling sites to document differences in the SAV community along salinity gradients.

Objective 3

Mayan cichlids were collected monthly from March 1996 to October 1997 with hook and line and cast nets from Taylor River. Ages were determined by examining thin section otoliths. Reproductive evaluations were based on nest distribution and size; fish length, weight, and sex; and gonad developmental stage. A review of six previous studies was used to evaluate the distribution and relative densities of introduced fish species across a variety of habitats.

3.3 Results

Objective 1

Fish density was positively related to higher water levels over both long and short-term periods. Sites with the longest hydroperiod, longest periods of continuous flooding, and highest mean water levels also had the highest fish densities. Presumably, these relationships are associated with greater recruitment during high water periods and high mortality during low water periods. Fish biomass was negatively related to periods of high salinity. Sites with the highest salinities had the lowest biomass, whereas sites with the lowest salinities had the highest biomass. Prolonged periods of low salinity and periods of high salinity variability were both correlated with increased biomass.

Objective 2

The most common vegetative species at three of the four fish sampling sites were *Utricularia* spp., *Chara hornemanii*, *Ruppia maritima*, *Batophora oerstedii*, *Najas marina*, and *Cladophora* spp.. Total SAV abundance at two of the three fish sampling sites was inversely related to salinity. Total SAV decreased dramatically during the late dry season, and *Utricularia* and *Chara* appeared to be adversely affected by salinities greater than 5 ppt and 15 ppt, respectively. In contrast, the abundance of *Ruppia* increased during the high salinity periods. *Ruppia* is a brackish water species capable of tolerating wide fluctuations in salinity. Total SAV did not decline during the dry season at the third site due to the emergence of *Cladophora*, a euryhaline green alga.

Objective 3

Fish were aged on the basis of annuli deposited on the otolith between January and May. The data indicate that Florida populations of Mayan cichlids grow slower and live longer than Mexican populations. The colder winters in Florida periodically slow the growth of Mayan cichlids resulting in the production of visible annuli. Consequently, it may be possible to age other species of introduced cichlids. Reproduction was influenced more by water level and salinity changes than by temperature. Most nests were observed along mangrove shorelines in April. Reproduction and parental care were completed by June when rising water levels flooded shallow habitats and dispersed the young. The Florida populations reached reproductive maturity at a greater size than in native regions, but produced approximately the same number of eggs per unit of body mass. The populations experienced a rise in the overall contribution to the fish community during 1996/1997 to 1998/1999.

3.4 Discussion

Objective 1

Results from each of the years comprising the monitoring period 1996-97, 1997-98, and 1998-99 were compared with data from pre-Test 7 years that had similar rainfall (1993-94, 1994-95, and 1992-93, respectively). There were very few differences in water level or salinity patterns between Test 7 years and pre-Test 7 years with similar rainfall. During 1996-97, water distribution to the four sampling sites was more equitable than in 1993-94, and water levels were similar at all of the sites. Fish densities were double those in 1993-94, and the number of species increased from 29 to 36. Two of the sampling sites had hydroperiods that extended through the dry season, and these two sites accounted for the overall increases. The increases were attributed to improved distribution of water and longer hydroperiods at two of the sites. However, since other water management changes had been implemented in addition to Test 7, it was not clear if Test 7 was fully or partially responsible for the improvements.

There were very few significant differences in water parameters between 1997-98 and 1994-95, and the differences that did occur were attributed to temporal variation in rainfall. There were no significant differences in fish density or biomass between these years.

Although rainfall amounts during 1998-99 were considerably lower than those during 1992-93, Test 7 was expected to offset the effect of lower rainfall on hydrology. However, the actual timing and amount of freshwater deliveries resulted in substantially higher salinities during this period. Consequently, a decrease in fish abundance was expected for this period. However, densities were not significantly different from those during 1992-93, and in some cases densities were actually higher. In addition, there were no significant differences in biomass between these years.

Overall, there were no differences in fish abundance and community structure between Test 7 years and the pre-Test 7 years. Failure to implement all of the conditions of Test 7 Phase I, along with the failure to implement any of the provisions of Phase II, precluded any success in retaining more wet season water in the southern Everglades. There were no apparent differences in the hydrology or hydrography of coastal wetlands during the last three years of Test 7. In addition, there were no differences in fish abundance or community structure during Test 7 as compared to pre-Test 7 years. Test 7 was never fully implemented, and consequently, had little effect on the coastal wetland ecosystem of northeastern Florida Bay.

Objective 2

Along the longitudinal transects extending downstream from these three sites, the dominant species changed from freshwater to euryhaline to marine. The outermost sites associated with two of these transects were dominated by *Halodule beaudettei*, and the third outer site was dominated by a combination of *Halodule beaudettei* and *Thalassia testudinum*. *Halodule beaudettei* and *Thalassia testudinum* are considered euryhaline and marine species, respectively.

The sampling sites associated with the fourth fish sampling location were heavily influenced by tidal influence and a lack of fresh water flow. Consequently, SAV dynamics at these sites were very different from the other three sites. No freshwater species were present at these sites, and the communities were more stable.

The preliminary results of this study indicate that large, rapid fluctuations in salinity have an adverse effect on SAV. These rapid changes do not allow time for successional shifts in community composition, leading to complete vegetation die-off.

Objective 3

An analysis of existing literature indicates that introduced species are most prevalent in canal and estuarine habitats and are less common in wet prairie habitats. Although the proportion of introduced species is greater in canals, they never exceeded 20 percent of the community by biomass. Three families comprised the majority of introduced species that were collected

during the reviewed studies: Cichlidae (5 species), Clariidae (1 species), and Poeciliidae (1 species). The current Test 7 monitoring study documented the population growth and decline of three species; Mayan cichlid, pike killifish (*Belonesox belizanus*), and black acaras (*Cichlasoma bimaculatum*); and the increase of spotted tilapia (*Tilapia mariae*) without a subsequent decline. Data indicate that the abundance of introduced species remains low in most habitats, and no changes in community composition are evident. The lack of catastrophic effects on native populations may be attributable to a native community largely comprised of generalists that may be resilient to disturbances and occasional drought and cold temperatures in wet prairies that may limit the abundance of introduced species.

3.5 Summary

Test 7 did not seem to effect fish abundance or diversity during 1997-1999 of the project. The data collected during Test 7 paralleled similar findings from pre-Test 7 studies. Although higher salinities were reported during this time, overall water condition parameters were not much different from other years of this project. Submerged aquatic vegetation was adversely affected by fluctuations in the speed and amount of salinity allowed within ENP. Introduced species still comprise a component of the fish community, but do not seem to be negatively affecting native fish populations at this time. Some growth and declines were evidenced in the fish community during Test 7.

3.6 References

- Faunce, C.H., H.M. Patterson, and J.J. Lorenz. In Review. Reproductive Biology of the Introduced Mayan Cichlid (*Cichlasoma urophthalmus*) in an Estuarine Mangrove Habitat of Southeastern Florida, USA. Fishery Bulletin.
- Faunce, C.H. and J.J. Lorenz. In Press. Reproductive Biology of the Introduced Mayan Cichlid (*Cichlasoma urophthalmus*) in an Estuarine Mangrove Habitat of Southeastern Florida, USA. Environmental Biology of Fishes.
- Lorenz, J.J. 1999. The Response of Fishes to Physiochemical Changes in the Mangroves of Northeast Florida Bay. Estuaries 22(2B): 500-517.
- Lorenz, J.J., C.C. McIvor, G.V.N. Powell, and P.C. Frederick. 1997. A Drop Net and Removable Walkway Used to Quantitatively Sample Fishes Over Wetland Surfaces in the Dwarf Mangroves of the Southern Everglades. Wetlands 3:346-359.

- Lorenz, J.J., D.L. Bean, C.H. Faunce, D.P.J. Green, J.P. McLendon, V. Oshaben, and R.J. Sawicki. 2000. Test 7 Ecological Monitoring Results: The Effects of Changes in Taylor Slough Water Delivery Patterns on the Mainland Coastal Wetlands of Northeastern Florida Bay: Aquatic Plants, Fish, and Roseate Spoonbills, Final Report. Report to the South Florida Research Center, Everglades National Park, Homestead, Florida.
- Lorenz, J.J., J.C. Ogden, R.D. Bjork, and G.V.N. Powell. In Review. Nesting Patterns of Roseate Spoonbills (*Ajaia ajaja*) in Florida Bay 1935-1999: Implications of Landscape Scale Anthropogenic Impacts. In J. Porter and K. Porter (eds). Linkages Between Ecosystems in the South Florida Hydroscape. St Lucie Press.
- Lorenz, J. J., J. P. McLendon, and C. H. Faunce. 1999. Test 7 Ecological Monitoring Results: An Analysis of the Hydrology and Resident Fishes within the Mangrove Ecotone of Everglades National Park, 1997-1998 Annual Report. Report to the South Florida Research Center, Everglades National Park, Homestead, Florida.
- Lorenz, J.J., J.P. McLendon, and C.H. Faunce. 1998. Test 7 Ecological Monitoring Results: An Analysis of the Hydrology and Resident Fishes within the Mangrove Ecotone of Everglades National Park, 1996-1997 Annual Report. Report to the South Florida Research Center, Everglades National Park, Homestead, Florida.
- Trexler, J.C., W.F. Loftus, F. Jordan, J. Lorenz, and J. Chick. In Press. Empirical Assessment of Fish Introductions in Southern Florida, U.S.A.: An Evaluation of Contrasting Views. Biological Invasions.

4.0 FISH AND MACROINVERTEBRATE MONITORING (1997-1999)

4.1 Introduction

The U.S. Army Corps of Engineers (ACOE) is proposing several projects to restore a more natural hydrology regime to the ecosystems within Everglades National Park (ENP). In order to complete the restoration projects, several tests have been completed to assess the effectiveness of these projects. The most recent test, the Test 7 Iteration, monitored the restoration efforts from the years 1997-1999. One aspect of the monitoring involves the direct and indirect effects these projects may have on threatened and/or endangered wildlife species and their habitat. The U.S. Fish and Wildlife Service (USFWS), in their Biological Opinion for this project, has cited several species that potentially may be impacted by these projects (USFWS 1999). Fish and macroinvertebrates are two wildlife groups that may be impacted by the restoration projects. In response to these concerns, a cooperative, long-term study between the ENP and Florida International University is being conducted to examine the distribution and composition of fish and macroinvertebrate populations in the ENP.

4.2 Methodology

The study compares data from sites that are proposed for impact, in Taylor Slough, to data from background locations, in Shark River Slough. Taylor Slough is located near Florida Bay and Shark River Slough is located near the Gulf of Mexico. This project consisted of four years worth of data collection, 1996-1999. Since Test 7 incorporated the evaluation of data from years 2-4 (1997-1999), this report will cover data from 1997-1999.

During 1997, the study focused on the macroinvertebrate community structure, large-fish sampling effort, and the emerging synthesis of aquatic animal community structure. In this year of the study, a before-after-control-impact experimental design, which includes use of background sites for comparison to areas where environmental alterations are proposed, was employed. Taylor Slough contains the sites where a change in water delivery schedules is proposed; Shark River Slough contains the background sites. The background sites in Shark River Slough are paired with the Taylor Slough sites based on their upstream distance from the southern Everglades mangrove fringe. New developments in 1997 sampling methods included the implementation of a sampling protocol for the electrofishing technique, and a special emphasis on aquatic invertebrates collected by the throw-trap. These techniques were incorporated into data sampling for 1998 and 1999.

4.3 Results

Results from 1997 indicated that Taylor Slough supports lower densities of macroinvertebrates and fishes than Shark River Slough (Trexler et al. 1998). In addition, there were significant differences in total phosphorus, total nitrogen, total carbon, and ash-free dry weight of soils between Shark River Slough and Taylor Slough, among sites within these sloughs, and between short and long hydroperiod plots in Taylor Slough. Aquatic plant volumes were greater in short-hydroperiod lots than in long-hydroperiod plots in Taylor Slough.

Fish density was generally higher in Shark River Slough than in Taylor Slough (Trexler et al. 1998). The Taylor Slough short-hydroperiod plots had the lowest or near lowest fish densities in all months they were sampled.

For large fish electrofishing, an analysis of variance of the catch-per-unit-effort (CPUE) revealed greater catch totals in Shark River Slough than in Taylor Slough (Trexler et al. 1998). In addition, CPUE from canal samples was significantly greater than from March samples.

Results from 1998 indicated that, in general, lengthening hydroperiod in ENP wet prairies increases the density of small fishes, but the relationship is not linear (Trexler et al. 1998). In addition, higher species richness of macroinvertebrates was observed in naturally nutrient-enriched sites in Shark River Slough. However, when the elevated number of organisms collected in these sites was taken into account, there was no difference in species richness between enriched and unenriched sites with similar hydroperiod.

The use of electrofishing in 1998 proved to be an efficient way to collect large fishes (>8 cm standard length) (Trexler et al. 1998). Large fish density differed among the water management areas examined. In particular Taylor Slough has low density of large fishes compared to Shark River Slough. There is a more marked seasonal pattern of fish abundance in the large fish data than in the small fish data.

Compared to values reported from other freshwater systems, standing stocks of periphyton in relatively undisturbed areas of the ENP were unusually high, and standing stocks of invertebrates and fish were unusually low (Turner et al. 1999). Fish standing stocks were much higher in phosphorus-enriched sites than in nearby reference sites, but invertebrate standing stocks were similar in enriched and reference sites.

Results from 1999 indicate that Taylor Slough often had lower fish density than at similar locations in Shark River Slough (Trexler et al. 2000). The annual density of fish collected by throw-trap increased with increasing hydroperiod in data from sites with hydroperiods of 120 to 300 days. At longer hydroperiods, the density of these fish does not increase, though the density of larger fish (>8 cm) does. Piscivorous species increased in abundance with increasing hydroperiod (Trexler et al. 2000). Fish in the 8 to 10 cm size range were most abundant at Shark River Slough sites.

4.4 Discussion

Lower densities of macroinvertebrates and fishes in Taylor Slough than in Shark River Slough probably is related to the shorter hydroperiod in Taylor Slough, but at the downstream reaches of each drainage may also be related to nutrient dynamics (Trexler et al. 1998). An earlier study also showed that water management activities may have altered salinity regimes in such a way that increased salinity may have resulted in the decrease in primary and secondary production in these environments (Lorenz et al. 1997).

An earlier study also has shown that the Mayan cichlid (*Cichlasoma urophthalmus*), an introduced species native to the Caribbean coast of Southern Mexico and Central America, was the most common species collected by weight and made up 90% of catch by biomass (Lorenz et al. 1997). This species may be displacing native species.

The non-linearity in the relationship in Year 3 between lengthening hydroperiod in ENP wet prairies and the density of small fishes may result from the series of wet years examined: sites with intermediate hydroperiods had not been dried for several years and may have been approximately long-hydroperiod sites for that time period (Trexler et al. 1999). Hydroperiod appears to explain more variation in small-fish density than local nutrient status if nutrient-elevated sites are excluded from the analysis. The study included locations with elevated soil phosphorus. These sites had unusually high small-fish density for their respective hydroperiods.

During 1998, the more marked seasonal pattern of greater fish abundance in the large fish data than in the small fish data may be because large fish are more sensitive to dry down and move to ponds well before the marsh dries, while small fish do not (Trexler et al. 1999). During 1998, data also indicated some movement of large fish into alligator ponds in the dry season of 1998, even though there was not a marked dry season.

Additional studies have shown that airboat-electrofishing provides a useful index of the abundance of large fishes in shallow, vegetated habitats, but length-frequency and species-composition data should be interpreted with caution. Additionally, emergent-stem density should be included as a covariate in statistical analyses of airboat-electrofishing (Chick et al. 1999).

Year 4 suggests that the lower fish densities in Taylor Slough than in similar sites in Shark River Slough may be related to the more frequent dry-down of Taylor Slough compared to Shark River Slough (Trexler et al. 2000). When adequate time passed between dry-down events, the fish density in Taylor Slough matched that in Shark River Slough. There generally was a 6-month to 1-year lag in fish density in Taylor Slough as fish communities recovered.

4.5 Summary

Overall, shorter hydroperiods decrease the densities of macroinvertebrates and fishes. Lengthening hydroperiod in the ENP wet prairies increases the density of small fishes. Alterations in historical salinity patterns may also play a role in the decrease of primary and secondary production in the ecosystem, thereby affecting the densities of macroinvertebrates and fishes. In addition, dry-downs should be spaced out in such a way as to allow fish communities to recover from one dry-down event to the next.

4.6 Literature Cited

- Chick, J. H., S. Coyne, and J. C. Trexler. 1999. Effectiveness of airboat electrofishing for sampling fishes in shallow, vegetated habitats. *North American Journal of Fisheries Management* 19:957-967.
- Loftus, W. F., O. L. Bass, Jr., and J. C. Trexler. 1997. Long-term fish monitoring in the Everglades: Looking beyond the park boundary. In D. H. Harmon, ed. *Making protection work: Proceedings of the 9th conference on research and resource management in parks and on public lands*. The George Wright Society, Hancock Michigan.
- Lorenz, J. J., C. Faunce, and D. Morrison. 1997. Monitoring resident fishes and ATLSS-related studies in the mangrove zone north of Florida Bay. *First Annual Report to South Florida Research Center, Everglades National Park*. Homestead, Florida.
- Trexler, J. 1997. First annual report: Fish and aquatic macroinvertebrates monitoring studies in Taylor Slough. Cooperative agreement between Everglades National Park, U. S. Department of the Interior, and Florida International University, Miami, Florida. CA-5280-6-9011.
- Trexler, J., J. Pechmann, and J. Chick. 1998. Second annual report: Fish and aquatic macroinvertebrates monitoring studies in Taylor Slough. Cooperative agreement between Everglades National Park, U. S. Department of the Interior, and Florida International University, Miami, Florida. CA-5280-6-9011.
- Trexler, J., J. Chick, and J. Pechmann. 1999. Third annual report: Fish and aquatic macroinvertebrates monitoring studies in Taylor Slough. Cooperative agreement between Everglades National Park, U. S. Department of the Interior, and Florida International University, Miami, Florida. CA-5280-6-9011.

- Trexler, J., J. Chick, and F. Jordan. 2000. Fourth annual report: Fish and aquatic macroinvertebrates monitoring studies in Taylor Slough. Cooperative agreement between Everglades National Park, U. S. Department of the Interior, and Florida International University, Miami, Florida. CA-5280-6-9011.
- Turner, A. M., J. C. Trexler, C. F. Jordan, S. J. Slack, P. Geddes, J. H. Chick, and W. F. Loftus. 1999. Targeting ecosystem features for conservation: Standing crops in the Florida Everglades. *Conservation Biology* 13:898-911.

5.0 AMERICAN CROCODILE MONITORING (1997-1999)

5.1 Introduction

The U.S. Army Corps of Engineers (ACOE) is proposing several projects to restore a more natural hydrology regime to the ecosystems within Everglades National Park (ENP). In order to complete the restoration projects, several tests have been completed to assess the effectiveness of these projects. The most recent test monitored the restoration efforts from the years 1997-1999, known as the Test 7 Iteration. One aspect of the monitoring involves the direct and indirect effects these projects may have on threatened and/or endangered wildlife species and their habitat. The U.S. Fish and Wildlife Service (USFWS), in their Biological Opinion for this project, has cited several species that potentially may be impacted by these projects (USFWS 1999). The American crocodile (*Crocodylus acutus*), a federally listed endangered species, is one of those protected species whose habitat may be impacted as part of these projects.

The status of the American crocodile population has long been a matter of concern, however, it now appears that the population has stabilized in this region (Ogden 1978; Mazzotti 1983; Kushlan and Mazzotti 1989). The exact number of American crocodiles is not known, but the majority of the United States population is centered in Florida Bay, ENP. However, as for other species of wildlife in southern Florida, the survival of crocodiles has been linked with regional hydrological conditions, especially water and salinity levels (Mazzotti 1983; Mazzotti 1989; Moler 1992). Alternatives for ecosystem restoration by improving water delivery into Florida Bay via Taylor Slough and the C-111 system, may change water and salinity levels in the receiving water bodies. In order to insure the continued survival of an endangered species in a changing environment, it is important to monitor that species population. American crocodile monitoring should investigate population parameters likely to be affected by alternatives proposed for ecosystem restoration. For crocodiles, one of the population parameters most susceptible to hydrological conditions is nesting effort and success.

5.2 Methodology

American crocodile nesting effort and success were determined by searching known and potential nesting habitat in ENP through April and May (effort) and July through August (success) for activity (tail drags, digging or scraping) or the presence of eggs or hatchlings (Mazzotti and Brandt 1998; Mazzotti 1999a; Mazzotti et al. 2000). Hatched eggshells or hatchling crocodiles were counted as evidence of successful nests. The number and causes of egg failure were noted whenever possible.

5.3 Results

During the 1997-1999 Test 7 Iteration, 50 nests were located in ENP (Figure 1) (Mazzotti and Brandt 1998; Mazzotti 1999a; Mazzotti et al. 2000). Thirty-five nests (70%) were successful over the three year study period, fourteen nests (28%) were depredated by raccoons (*Procyon lotor*) and one nest (2%) outcome was undetermined (Table 1).

5.4 Discussion

American crocodile nests were distributed throughout ENP. The same nesting areas were utilized by crocodiles on a regular basis. However, some interesting trends were observed at some nest area locations. Nest sites were lost following the reconstruction of the East Cape Plug, but additional nesting area was utilized north of the plug following construction activities. Other nesting areas, including Cape Sable and Madeira Beach, continue to have low nesting success due to nest predation by raccoons (*Procyon lotor*). Two nesting locations, Buttonwood Canal and West Lake, continue to be important habitat for juvenile crocodiles. However, these areas are also utilized heavily by day-use visitors for motorboating, kayaking, canoeing and other recreational activities. Existing information indicates these human-related recreational activities are not negatively impacting the crocodiles (Mazzotti 2000).

Mortality of hatchling crocodiles has been associated with the distance that hatchlings have to disperse to find nursery habitat (Mazzotti 1999b). Nursery habitat can be defined as areas that are protected from wind and wave action, have a low to intermediate salinity regime, abundant food, and places to hide from predators. In Florida estuarine creeks, natural and man-made ponds and canals meet these habitat requirements. On North Key Largo nests are adjacent to nursery habitat. At other locations, the distance from nest to nursery can range from meters to hundreds of meters. In ENP, most hatchlings are marked from shoreline which can be kilometers from nursery habitat. We assume that greater dispersal distance primarily increases the risk to predation, however, it may also expose a hatchling crocodile to harsher environmental conditions during transit. For a hatchling crocodile, the surest way to avoid the threat of predation is to outgrow it.

In south Florida, near Florida Bay, the creation of canals not only unwittingly created nesting habitat, but also created a productive aquatic environment as evidenced by the growth rates of crocodiles and observations of abundant prey items at the two locations. Even so, lower growth rates at both locations have been associated with spatial or temporal patterns of higher salinity (Brandt and Mazzotti, in prep.; Moler 1992). In northeastern Florida Bay in ENP lower aquatic productivity has been associated with elevated salinities caused by diversion of freshwater for drainage and flood control (J. Lorenz, pers. comm. to F. Mazzotti, 1999). Although faster growth decreases exposure to the threat of predation by non-crocodilian predators, it also shortens the time it takes to become a subadult, and hence, a threat to adult crocodiles. When a population of crocodiles has good nest success and adequate hatchling

survival, mortality and dispersal of older juveniles and subadults become the most likely factors to limit population numbers.

Although the annual number of nests located during the Test 7 Iteration was fairly consistent, the number of nests located in ENF has varied over the past 30 years (Mazzotti and Brandt 1998; Mazzotti 1999a; Mazzotti 1999b; Mazzotti et al. 2000). Nesting success appears to be very high for this species, although nest predation by raccoons appears to limit the success of crocodiles in some areas. Additionally, some human activities such as canal and/or levee manipulation may disturb crocodile nesting locations at least for a brief periods of time.

5.5 Summary

Overall, nesting activity and nesting success for the American crocodile have remained at relatively normal levels during the Test 7 study. Although this study was undertaken for only three years, no adverse trends were evidenced from the data collected. Any fluctuations evidenced from the Test 7 Iteration should be tempered with caution, since only consistent long-term studies of endangered species will reveal trends versus short-term fluctuations (Mazzotti 1999b). However, one area of concern deals with fresh water or salt water intrusion and the volume of that intrusion from either natural or man-made events. An abundance of salt water may decrease aquatic productivity, thus negatively impacting crocodile resources. The volume of fresh water or salt water may also impact crocodile reproductive efforts during the nesting season. If too much water floods or is diverted to a known nesting area, the higher water levels may inundate and destroy the nest contents. Establishing and maintaining the appropriate salinity, coupled with maintaining the appropriate volume of water, can help to maintain and possibly increase the number of American crocodiles in Everglades National Park.

5.6 Literature Review

- Mazzotti, F. J. 1983. The ecology of the American crocodile in Florida. Ph.D. Thesis. Pennsylvania State University.
- Mazzotti, F. J. 1989. Factors affecting the nesting success of the American crocodile (*Crocodylus acutus*) in Florida Bay. Bull. Mar. Sci. 44:220-228.
- Mazzotti, F. J. 1999a. A final report on the 1998 monitoring program for the endangered American crocodile in Everglades National Park. University of Florida. 4 pages.
- Mazzotti, F. J. 1999b. The American crocodile in Florida Bay. Estuaries. Vol. 22, No. 2B. Pages 552-561.

- Mazzotti, F, J. and L. A. Brandt. 1998. A report on the 1997 monitoring program for the endangered American crocodile in Everglades National Park. University of Florida. 7 pages.
- Mazzotti, F, J., M. S. Cherkiss, and C. Zweig. 2000. The 1999 monitoring program for the endangered American crocodile in Everglades National Park. University of Florida. 11 pages.
- Moler, P.E. 1992. American crocodile population dynamics. Final Report. Florida Game and Fresh Fish Commission. Tallahassee, FL. 23 pp.
- Kushlan, J. A. and F. J. Mazzotti. 1989. Population biology of the American crocodile. J. Herp. 23:7-21.
- Ogden, J. 1978. Status and biology of the American crocodile, *Crocodylus acutus* (Reptilia: Crocodylidae) in Florida. J. Herp. 12 183-196.
- U.S. Fish and Wildlife Service. 1999b. U.S. Fish and Wildlife Service Final Biological Opinion for the U.S. Army Corps of Engineers, Modified Water Deliveries to Everglades National Park, Experimental Water Deliveries Program, Canal 111 Project. 115 pages.

6.0 CAPE SABLE SEASIDE SPARROW (1997-1999)

6.1 Introduction

The U.S. Army Corps of Engineers (ACOE) is proposing several projects to restore a more natural hydrology regime to the ecosystems within Everglades National Park (ENP). In order to complete the restoration projects, several tests have been completed to assess the effectiveness of these projects. The most recent test monitored the restoration efforts from the years 1997-1999, known as the Test 7 Iteration. One aspect of the monitoring involves the direct and indirect effects these projects may have on threatened and/or endangered wildlife species and their habitat. The U.S. Fish and Wildlife Service (USFWS), in their Biological Opinion for this project, has cited several species that potentially may be impacted by these projects (U.S. Fish and Wildlife Service 1999a). The Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*), a federally endangered bird, is one species that may be impacted by the restoration projects.

The Cape Sable seaside sparrow (CSSS) is found only in the Everglades portions of Dade and Monroe Counties in south Florida. This bird is non-migratory and isolated from other breeding populations of seaside sparrows (U.S. Fish and Wildlife Service 1999b). The preferred nesting habitat of the CSSS appears to be short-hydroperiod mixed marl prairie communities that often include muhly grass (*Muhlenbergia filipes*) (Stevenson and Anderson 1994). These short-hydroperiod prairies contain moderately-dense, clumped grasses, with open space permitting ground movements by the CSSS. The suitability of this vegetative community for the sparrow is driven by a combination of hydroperiod and periodic fires (Kushlan and Bass 1983). Several studies (Armentano et al. 1995, Curnutt et al. 1998, Nott et al. 1998) have documented a tight correlation between increased hydroperiods resulting from current water management practices, and shifts in CSSS habitat areas from mixed marl prairie vegetation suitable for breeding to sawgrass-dominated vegetation that sparrows do not use for nesting. Hydroperiods that sustain the short-hydroperiod prairies are considered essential for the CSSS to successfully breed and are considered necessary to ensure the species survival (U. S. Fish and Wildlife Service 1999b). Fires prevent hardwood species from invading these communities and prevent the accretion of dead plant material, both of which decrease the suitability of these habitats for the CSSS. Although fire plays an important role in providing appropriate CSSS habitat, this report focuses only on how hydroperiod affected the CSSS during the Test 7 Iteration.

6.2 Methodology

Surveys were conducted during the breeding seasons, 1997-1999. Surveys were conducted for about two hours each morning starting soon after sunrise. Observers were dropped off using a helicopter to a predetermined survey point. The survey points were located 1 km apart from

one another in a non-random design (See Figures 1 and 2 for 1997 and 1998 survey points, respectively). Every bird seen or heard was recorded. The total number of actual birds recorded was then corrected to give an estimate for the total population following Bass and Kushlan (1982) methodology.

6.3 Results

Table 1 shows that Cape Sable seaside sparrow subpopulation estimates fluctuated during the Test 7 study (U.S. Fish and Wildlife Service 1999b, Pimm 1999). Subpopulation F was the only population that remained stable during the three-year study. Subpopulation A contained an estimated 272 sparrows in 1997, then dropped to 192 sparrows in 1998 before rebounding in 1999 to an estimated 400 birds. Subpopulation B sparrow numbers were highest during 1997, with an estimated 2832 birds. During 1998, the estimated population of Subpopulation B dropped to 1808 before increasing to an estimated 2048 sparrows in 1999. Subpopulations C and D had population estimates of 48 for 1997. Sparrow Subpopulation C increased to 80 in 1998, and 144 in 1999. Subpopulation D population estimation remained the same during 1998, and more than tripled the population in 1999. Subpopulation E increased from an estimated 832 sparrows in 1997 to 912 sparrows in 1998, but declined to 768 during the 1999 breeding season. Overall, the CSSS population estimates were highest at the beginning of the Test 7 Iteration, declined in 1998 and increased in 1999. However, the 1999 population estimate was still below the 1997 population estimate.

Table 1. Cape Sable Seaside Sparrows Population Estimates from Everglades National Park, 1997-1999.			
Subpopulation	1997	1998	1999
A	272	192	400
B	2832	1808	2048
C	48	80	144
D	48	48	176
E	832	912	768
F	16	16	16
TOTAL	4048	3056	3552

6.4 Discussion

The Cape Sable seaside sparrow population fluctuated every year during the Test 7 Iteration. In particular, Subpopulations A, B and E exhibited negative population fluctuations at least once during the Test 7 Iteration compared to Subpopulations C, D and F. Population fluctuations have been attributed to two main events; hurricanes and water management

practices. These two events are believed to be the two important factors in influencing the CSSS population, especially within the last 9 years (Bass 1998, U.S. Fish and Wildlife Service 1999b). Hurricanes impact CSSS populations through direct mortality and habitat destruction, in addition to indirect impacts such as excessive flooding, habitat modification from fresh-water inundation, and invasion of exotic plant species that create unsuitable CSSS habitat conditions (U. S. Fish and Wildlife Service 1983, Curnett et al. 1998, U. S. Fish and Wildlife Service 1999b). The most recent hurricane to impact the Everglades region was in 1992 when Hurricane Andrew significantly reduced subpopulations A, C, E, and F. While some subpopulations have been able to recover from that hurricane, other subpopulations have not as successful returning to pre-hurricane populations.

In addition to hurricanes, water management practices are blamed for the slow population recoveries (U.S. Fish and Wildlife 1999b). Providing the appropriate water management schedule can assist in protecting, enhancing and restoring CSSS habitat to allow the populations to return to the pre-Hurricane Andrew population. One way to accomplish CSSS population increases is to closely regulate the amount and duration of water occurring in CSSS habitat. As required by the U.S. Fish and Wildlife Service in their Biological Opinion (U. S. Fish and Wildlife Service 1999a), specific water level heights, time periods and release times are outlined for each subpopulation. Consultation between personnel from ENP, South Florida Water Management District (SFWMD), ACOE, the U.S. Fish and Wildlife Service and other interested parties should continue in order to create better water management regimes for the CSSS especially during the breeding season.

Although year to year bird population fluctuations are not uncommon (Pimm 1991), negative population swings can severely impact species that are already endangered. Because of the strict habitat parameters required by the CSSS, any habitat modifications can cause the population to temporary or permanently vacate the area. In addition to hurricanes and other natural events, man-made modifications of the Everglades hydrology has compounded maintaining appropriate CSSS habitat.

6.5 Summary

According to the U.S. Fish and Wildlife Service, the best information available for the CSSS indicates that current water management practices and hurricanes in the Everglades region primarily are responsible for sparrow population declines since the early 1990's (U.S. Fish and Wildlife Service 1999b). Observations made during the Test 7 Iteration monitoring revealed fluctuations in CSSS subpopulations. The reasons for these fluctuations cannot be attributed to one factor. However, appropriate manipulation of water to ENP during the breeding season is necessary in order to provide the appropriate CSSS habitat. The U.S. Fish and Wildlife Service, in consultation with the SFWMD, ENP, ACOE, and other interested parties, has established in their Biological Opinion that certain water management regimes must be implemented in order to provide appropriate habitat for the CSSS. Maintaining these water

management regimes should provide the opportunities for the CSSS to increase their population similar to pre-Hurricane Andrew populations.

6.6 Literature Cited

- Armentano, T. V., R. F. Doren., W. J. Platt, and T. Mullins. 1995. Effects of Hurricane Andrew on coastal and interior forests of southern Florida: Overview and synthesis. *J. Coastal Res. Spec.* 21:111-144.
- Bass, O. L., Jr., and J. A. Kushlan. 1982. Status of the Cape Sable sparrow. U. S. Department of the Interior, National Park Service, South Florida Research Center Report T-672; Homestead, Florida.
- Bass, O. L., Jr. 1998. Information from annual report to the U.S. Army Corps of Engineers, Jacksonville, Florida. December, 1998.
- Curnutt, J. L., A. L. Mayer, T. M. Brooks, L. Manne, O. L. Bass, D. M. Fleming, M. P. Nott., and S. L. Pimm. 1998. Population dynamics of the endangered Cape Sable seaside-sparrow. *Animal Conservation* 1:11-21.
- Kushlan, J. A., and O. L. Bass Jr. 1983. Habitat use and distribution of the Cape Sable seaside sparrow. *In* The seaside sparrow, its biology and management: 139-146. North Carolina Biological Survey and North Carolina State Museum.
- Kushlan, J. A., O. J. Bass, Jr., L. L. Loope, W. B. Robertson, Jr., R. C. Rosendahl, and D. L. Taylor. 1982. Cape Sable seaside sparrow management plan. South Florida Research Center Report M-660. U. S. Department of the Interior, Everglades National Park; Homestead, Florida.
- Nott, M. P., O. L. Bass, Jr., D. M. Fleming, S. E. Killefer, N. Fraley, L. Manne, J. L. Curnett, T. M. Brooks, R. Powell and S. L. Pimm. 1998. Water levels, rapid vegetational changes, and the endangered Cape Sable seaside sparrow. *Animal Conservation*. 1:23-32
- Pimm, S. L. 1999. The 1999 Cape Sable Sparrow Survey. Internet address: <http://web.utk.edu/~grussell/csshtml/csss.html>
- Stevenson, H. M. and B. H. Anderson. 1994. The birdlife of Florida. University Press of Florida; Gainesville, Florida.
- U.S. Fish and Wildlife Service. 1983. Cape Sable seaside sparrow recovery plan. U. S. Fish and Wildlife Service; Atlanta, Georgia.

U.S. Fish and Wildlife Service. 1999a. U.S. Fish and Wildlife Service Final Biological Opinion for the U.S. Army Corps of Engineers, Modified Water Deliveries to Everglades National Park, Experimental Water Deliveries Program, Canal 111 Project. 115 pages.

U.S. Fish and Wildlife Service 1999b. South Florida Multi-species Recovery Plan. Cape Sable Seaside Sparrow. Pages 435-370.

SUB - APPENDIX A

Test 7 Program Monitoring Agreement

DRAFT

MONITORING PROGRAM EXPERIMENTAL PROGRAM OF WATER DELIVERIES TO ENP

The Ecological and Hydrologic Monitoring Program referenced in the October 5, 1995 Concurrence Agreement is described below. It covers issues and concerns related to Test 7 of the Experimental Program of Water Deliveries to Everglades National Park (Experimental Program).

The National Park Service agreed to take the lead in developing the monitoring plan for the Test 7 iteration, as specified in item 4 of the October 5, 1995 Concurrence Agreement. Representatives of the National Park Service (NPS), the Corps of Engineers (Corps), the South Florida Water Management District (SFWMD), and the Fish and Wildlife Service (FWS) jointly formulated this ecological monitoring plan for Test 7. The agencies were represented by Tom Armentano, Dave Busch, Bob Johnson, and Dave Sikemma (NPS), Steve Sutterfield, Jim Vearil, and Susan Bullock (Corps), John Ogden, Dave Rudnick, Jocelyn Branscome, and Susan Olson (SFWMD), and Craig Johnson (FWS).

I Ecological Monitoring Plan Element

The plan outlined here was developed to assess ecological responses during the period of Test 7, and to establish ecological baselines for future iterations of the Experimental Program. The geographical area of coverage for this monitoring program is all portions of the southern Everglades region predicted to be affected by the Experimental Program. The monitoring elements were derived from (1) results of the interagency effort to recommend ecological monitoring measures for the Experimental Program of Water Deliveries to Everglades National Park (Experimental Program), (2) monitoring commitments appearing in Table 2 of the Test 7 Preliminary EA, and (3) the Biological Opinion for this project under the Endangered Species Act (ESA) Section 7 consultation.

The agency representatives decided to rate potential monitoring elements on four criteria (Table 1). The first of these was their potential sensitivity to hydrological change. As used in this discussion, this is an estimation of the responsiveness of the monitoring elements to the kinds of changes we are trying to effect through Test 7. There was strong support for the proposition that temporal and spatial scale is critical to the selection of appropriate factors for monitoring of the Experimental Program. The greatest probability for detecting ecological effects that are likely to be induced by the relatively small amount of hydrological change planned for Test 7 lies in focusing investigations upon lower trophic level

organisms. Comments on Test 7 monitoring sensitivity (Table 1) reflect this proposition and not other criteria, such as priorities arising from Test 7 ESA consultation or value as overall indicators of ecosystem restoration.

The second major criterion for ranking of potential monitoring measures was the ESA Section 7 consultation for Test 7. Reasonable and prudent alternatives for the Cape Sable seaside sparrow, as well as conservation recommendations for the American crocodile and wood stork, were used as guidelines in determining rankings and agency responsibilities for conducting monitoring projects. High relevance on either of the first two criteria was grounds for including monitoring measures on the list of those recommended for support.

Also of importance in rating the various potential monitoring measures was their relative value as environmental baselines. Higher priority was assigned where current baseline data are in need of continuation, are incomplete, or are nonexistent. Finally, the relevance of monitoring data to ongoing modeling efforts (ATLSS or ELM) was considered, although not given equivalent weight to the first two criteria.

There was not complete agreement between those measures recommended as sensitive monitoring indicators and those studies that may be needed to fulfill institutional requirements (e.g., the Endangered Species Act). However, a higher rating resulted where monitoring would provide information in both realms, or benefit a related area (e.g., development of a baseline for future modifications or empirical information for modeling).

The components of the ecological monitoring program identified as "Essential" (Table 1) are considered to be the minimum tasks necessary to evaluate the ecological responses to Test 7. Those components identified as "Moderate" would provide additional information for interpreting Test 7, but were not considered to be as high a priority as the "Essential" measures. Those elements rated Moderate would not be a part of the Test 7 monitoring program although agencies may wish to support these measures based on their importance to other programs.

The production of ecological monitoring assessments will require information on the hydrological effects of Test 7, expressed in formats and on schedules that are most useful for ecological interpretation. The additional monitoring stations recommended by NPS hydrologists should permit more complete analyses of Park hydrological conditions throughout Test 7. These are summarized in the attachment to this Plan entitled "Hydrological Monitoring and Report Preparation." Stage hydrographs, stage-duration curves, water depth difference plots, and water depth contour maps produced from the interagency hydrological network will be used to produce ecological analyses of the Test's effects. At a

minimum, hydrological inputs to these analyses must cover annual wet and dry season variation, as well as major local precipitation events, or regulatory water releases based on regional precipitation. Critical information needs are peak wet season stages, minimum dry season water levels, and periods of inundation. Although the emphasis is on hydrological change as a forcing variable, ecological studies should also incorporate information on key "secondary" factors from ongoing monitoring efforts dealing with water quality (especially nutrient loading and salinity) and disturbance (e.g., fire or storms), where appropriate and practical.

Agency representatives for the ecological sciences will reconvene semiannually to assess progress throughout the course of the Test 7 ecological monitoring program. NPS will continue to facilitate interagency review of the monitoring program. Table 2 presents the schedule that was agreed upon for the Test 7 monitoring process.

To the greatest extent possible, timetables for agency cooperators or contractors in the Test 7 monitoring process should be set to meet this schedule. It is impractical for any monitoring efforts not currently ongoing to be put in place by November 1, 1995. However, each agency will expedite the process of initiating the elements of this plan for which it is responsible. Annual and final reports will be compilations of individual investigator reports. The agency representatives for Test 7 monitoring will produce an integrated summary of the various hydrological and ecological reports as part of each annual and final report.

The recommended Test 7 monitoring plan is outlined in the narrative that follows, as well as in Table 1.

Freshwater Fish and Macroinvertebrates

NPS has developed a long-term data base on fish and aquatic macroinvertebrates inhabiting Shark River Slough. However, aquatic biota from Taylor Slough and the C-111 Basin are likely to be more heavily affected by Test 7 hydrological manipulations. Information on aquatic biota is needed for ATLSS modeling and to more fully understand wading bird foraging ecology. While NPS can restructure its program to some degree to evaluate project influences, the recent completion of two cooperative research efforts signals a reduction in overall field effort for fish and macroinvertebrates. Additional support is required to cover freshwater and transitional areas of the Taylor Slough and C-111 drainages.

To fill the gap in existing fish and invertebrate sampling programs for Test 7, effort must be shifted to Taylor Slough and the short hydroperiod wetlands in the eastern Everglades. The

sensitivity of organisms to hydrologic change in these regions is high, and would be particularly valuable if the surveys are modified to determine how the Experimental Program affects larger size classes of fish. This is important because wading birds, particularly wood storks, feed preferentially on larger prey size classes. The need to establish a baseline on freshwater fish and macroinvertebrates is great in Taylor Slough and the eastern Everglades. Continued studies in Shark River Slough contribute to the baseline that has been developed over 20 years. Surveys for fish and macroinvertebrates (as well as most other elements) should be conducted along cross-drainage gradients.

Recommendations:

- a. Support for the type of survey currently underway in lower Taylor Slough/Florida Bay (Lorenz) will be provided by the Corps.
- b. Freshwater fish and macroinvertebrate surveys in Taylor Slough will be initiated by the Corps by either extending the lower Taylor Slough work up the drainage or by arranging for another investigator.
- c. Continuing the fish and macroinvertebrate monitoring in Shark River Slough will be given a high priority by the NPS. The present level of effort will be maintained.

Plant Communities

Investigators have reported rapid vascular plant community response to the recent high water conditions in ENP. However, past monitoring projects have not been specifically designed to evaluate vegetation change resulting from the Experimental Program. A relatively small amount of additional support is required to supplement ongoing efforts to evaluate plant community responses and the mechanisms of plant response to hydrological variation.

New transects will be placed in northern Taylor Slough to establish a baseline there. Data will be collected along vegetation transects elsewhere in the ENP to monitor the effects of the Experimental Program. To the degree possible, study areas will be co-located with the focal areas used by the University of Georgia mapping effort.

Recommendation: NPS will continue vegetation surveys along existing transects in Taylor Slough and will conduct supplemental analyses devised to evaluate how shrub invasion and fire affect marsh habitat.

Algal Communities

Periphyton research will be rescaled from the more-focused experimental approach currently employed by FIU scientists working in Shark River Slough up to landscape-level monitoring. Test 7 monitoring suitability is high, and these studies are essential. Floating vegetative complexes (including *Utricularia*) are very responsive to changes in hydroperiod, water quality, and nutrient loading. In scoping a periphyton study, emphasis will be placed on the ecological effects of the Experimental Program, not basic research.

Recommendation: Because SFWMD has some expertise in this area and because this measure can be linked to Emergency Interim Plan responsibilities associated with Test 7, SFWMD will take lead responsibility for implementing a periphyton monitoring project by 1st qtr. CY96.

SRF Wading Bird Surveys

SRF surveys for wading birds provide information on wading bird distribution, abundance, and foraging patterns in relation to hydropattern. The 10 years of SRF data already available cover a range of wading bird responses to environmental variation throughout the Everglades. This data base is thought to be sufficient for ongoing modeling efforts and to serve as an adequate baseline for future measurements. Information from SRF surveys is better applied to evaluating larger regional scale ecosystem change rather than the type of change anticipated during Test 7.

There is more than a decade of SRF survey data for the ENP, but these data have not been analyzed. Until analyses and reports are produced, agency resources should be focused on other aspects of the monitoring plan.

Recommendation: The National Biological Service (NBS) is responsible for analyses and reports from the unanalyzed portions of the SRF data base. NPS, FWS, and the Corps will fund completion of reports by an independent scientist if NBS is unable to produce a complete set of reports on wading bird distribution and abundance by June 1996. As currently envisioned, new SRF data will not be needed for Test 7 ecological analyses.

Wading Bird Nesting Surveys

Aerial surveys and colony visits are used to evaluate wading bird nesting success. As with SRFs, variation in wading bird productivity may be more easily attributable to factors operating over broad spatial and temporal scales, rather than small scale

hydrological modifications. However, the colony patterns are considered to be strong indicators of ecological conditions in the Everglades region.

There are three options proposed for these surveys: (1) aerial surveys of all wading bird colonies, including wood stork colonies with a fixed wing aircraft, (2) aerial surveys of only wood stork colonies, and (3) supplement the fixed-wing surveys with helicopter checks of the wood stork sites to gain more detailed data on chick growth and survival.

Recommendation:

a. NPS will continue to fly wading bird surveys and will add the helicopter checks of the wood stork sites. A standardized colony survey protocol consistent with that used in other regions of the Everglades will be used.

b. FWS will provide additional funds or staff support as needed.

c. The Corps will support wading bird breeding ecology surveys in the WCAs. Colony surveys will be conducted by the standard protocol.

Wood Storks

Wood storks have been monitored along with other wading birds as part of the program described above. The above recommendations for wading bird colonies and distribution and abundance surveys will satisfy the Conservation Recommendation in the ESA Section 7 Biological Opinion.

Cape Sable Seaside Sparrow (CSSS)

NBS has had the lead on CSSS studies through the work of Dr. Stuart Pimm (Univ. of Tennessee) and is the appropriate source for the required studies of sparrow biology.

Reasonable and Prudent Alternative No. 3 in the ESA Section 7 Biological Opinion can be fulfilled by funding the efforts of Pimm to monitor the CSSS. NPS, FWS, and the Corps will support aspects of Pimm's proposal that are related to monitoring, but this may not fully address portions of the CSSS investigation that are related to model development.

Recommendations:

a. The Corps, NPS, and FWS will jointly support the CSSS monitoring project. FWS may use in-kind services for some of this support and the Florida Game and Fresh Water Fish Commission will be requested to provide additional in-kind survey support.

b. NBS will seek alternate funding sources for aspects of the Pimm proposal related to model development or for studies of winter ecology of the CSSS.

Alligator Nesting Surveys

These surveys are carried out using a combination of SRF surveys to locate nests and nest visits to document productivity. Surveys were recently expanded to cover Taylor Slough in an attempt to better document the effects of the Experimental Program. Alligators are a keystone species in the Everglades and are sensitive to hydrological change, while also causing substantial physical alteration to the ecosystem.

Recommendation: NPS will continue surveys of nesting alligators making sure that the Taylor Slough Basin is covered.

American Crocodile

Ongoing support of the effort to monitor crocodile nesting patterns in Florida Bay would satisfy the conservation recommendation made for this species in the Biological Opinion. Test 7's effects may be substantial in its habitat.

Recommendation: FWS, NPS, and the Corps will ensure continued crocodile monitoring.

Florida Panther

NPS conducts aerial surveys of telemetered panthers within ENP and has plans to continue this effort. Test 7 ecological monitoring sensitivity is low, so this species will not be considered as a Test 7 monitoring element.

Snail Kite

Recent snail kite research in the vicinity of ENP has been conducted for NBS by Rob Bennett (University of Florida). Expansion of survey efforts within the Test 7 project area would require additional resources. Test 7 monitoring priority for this species is low. Therefore, the snail kite will not be part of the monitoring program for Test 7.

Table 1: Major elements of the ecological monitoring program for Test 7

Rating	Monitoring Element	Comments	Basins	Responsible Agency
Essential	Fish and macroinvertebrates	Sensitivity is high; Marginal applicability to the Section 7 consultation; Importance to baseline is high; Modeling needs relative to ATLSS.	Taylor FL Bay SRS	Corps NPS
Essential	Plant communities	Sensitivity is high; Some applicability to the Section 7 consultation on sparrow habitat; High value for establishing a baseline in Taylor Slough; Modeling needs high relative to ELM.	SRS Taylor	NPS
Essential	Periphyton	Sensitivity is high; No direct applicability to the Section 7 consultation; Would be establishing a baseline; Modeling applicability is high.	Taylor	SFWMD
Moderate	SRF wading bird surveys	The applicability of these surveys to a monitoring program for Test 7 is uncertain; priority will be placed on the existing data set from 10 years of SRF surveys; new wading bird SRFs can not be recommended for monitoring Test 7.	SRS Taylor WCAS C-111	NBS-complete report from existing data set; NPS, FWS, and Corps will support analysis and write-up if NBS is unable to complete
Essential	Wading Bird Colonies	Ecological sensitivity is thought to be high; close connection to Section 7 consultation (see wood stork); continuation of the Everglades baseline is important; modeling needs marginal.	SRS Taylor	NPS Corps

Table 1: Major elements of the ecological monitoring program for Test 7 (Continued)

Rating	Monitoring Elements	Comments	Basins Responsible Agency
Essential	Alligator nesting surveys	Sensitivity of alligators to Test 7 monitoring is potentially high; it has no applicability to the Section 7 consultation; it is fairly important for future baselines and is the subject of ATLSS modeling.	Taylor NPS
Essential	Cape Sable seaside sparrow	Sensitivity is moderate; it is central to the biological opinion; development of a baseline is important; data will be useful to ATLSS modeling but may require additional funding.	Taylor Corps SRS FWS C-111 NPS
Essential	Wood Stork	Sensitivity of wood storks to Test 7 may be high; important for Section 7; the importance of nesting data to the baseline for future management action is relatively high; data would be collected as part of a larger effort to evaluate wading bird colonies.	Taylor See wading bird colonies and SRFs
Essential	American crocodile	Ecological sensitivity may be high depending on salinity tolerance; high relevance to Section 7 consultation; low need to develop a baseline; does not directly benefit model development.	Taylor FWS, NPS, and Corps FL Bay will investigate continuing surveys.
Moderate	Florida panther	Sensitivity low; Do not recommend including separate studies to assess the effects of Test 7; abundance too low for baseline; is subject of ATLSS model.	SRS Taylor None
Moderate	Snail kite	Sensitivity moderate; studies to assess the effects of Test 7 not recommended.	SRS WCAs None

II Hydrologic Monitoring Plan Element

Test Iteration 7 proposes to evaluate methods to restore a more natural hydroperiod to ecosystems within Everglades National Park. The hydrologic monitoring plan for test iteration 7 will continue the monitoring efforts that have been in place during the previous test iterations and will include new monitoring sites within Everglades National Park and along L-31N, L-31W and C-111. A hydrological monitoring group will be established from the NPS, SFWMD, USGS and the Corps, for data acquisition and hydrologic analysis for the Experimental Program.

Introduction

There is a well established long-term hydrological monitoring program in place throughout much of the freshwater and marine ecosystems of South Florida. Although this monitoring system is adequate for characterizing the overall water level and rainfall conditions within the system, recent analyses have shown that coverage of the short hydroperiod marl prairies is sparse. For this reason, additional hydrologic monitoring stations have been proposed for installation during Test 7. These sites are located throughout the Rocky Glades and the central and lower portions of Taylor Slough, and one new site is located in the western Shark River Slough marl prairies. For modeling purposes several new groundwater sites are being installed along the L-31N Canal, the C-111 Basin, and in the developed areas east of L-31N. The expanded network covers much of the area that will be most directly impacted by the operational changes implemented under Test 7 and will also provide needed baseline information for hydrological and ecological evaluations related to the Modified Water Deliveries and C-111 GRR projects.

Monitoring Areas

Test Iteration 7 will focus on the following areas:

1. **Northeast Shark River Slough (NESRS).** An experimental water delivery plan for Northeast Shark River Slough was implemented in July 1985, and has continued to the present. In conjunction with this program, an extensive monitoring network was initiated through the cooperative efforts of the USGS, NPS, Corps, and SFWMD. Monitoring of selected existing sites is an ongoing effort to determine how the surface and groundwater gradients are influenced by the raising of the L-31N Canal stage. Refer to figures 1A and 1B for all locations of monitoring stations within the Experimental Program. Sites in the vicinity of known Cape Sable seaside sparrow nesting areas will be monitored.

2. **Taylor Slough.** Several new monitoring sites will be added in the Taylor Slough Basin, and existing gages will be upgraded. Pre- and post-conditions will be compared to determine basin changes in surface and groundwater.

3. **Rocky Glades Area.** The area of higher ground elevations between Shark River Slough and Taylor Slough is referred to as the Rocky Glades area. Additional groundwater sites will be added for monitoring during this test.

4. **8.5 Square Mile Area.** The residential area known as the 8.5 square mile area is bounded on the east by L-31N and on the north and west by the Everglades National Park boundary. Unusually severe weather during 1993 and 1994 resulted in high water levels in this area. Two additional groundwater monitoring sites will be constructed for this test and pre- and post-project conditions will be compared to determine basin changes in surface and groundwater.

5. **Lower C-111 Basin.** Beginning in 1984, the SFWMD and USGS established a network of surface and groundwater monitoring sites within the freshwater marshes adjacent to C-111. This network consists of five surface water recording gauges (EVER1, EVER2A, EVER2B, EVER3, and EVER4) and two groundwater water stations G-3354 and G-1251. Hydrologic monitoring of these existing stations will continue throughout the duration of the test. An additional groundwater monitoring site is proposed along C-110, and existing stations will be upgraded.

Water supply to the ENP Eastern Panhandle flows through a series of gaps spaced along the south levee of C-111 between S-18C and S-197. Natural ground elevations at these gap openings range from 0.6 to 1.6 ft., NGVD. Baseline hydrology for these gages has been established and hydrologic monitoring will continue throughout the duration of the test. Pre and post conditions will be compared to determine basin changes in surface and groundwater.

6. **Florida Bay.** Various studies are currently being conducted by SFWMD, NPS, Dade County Environmental Resource Management (DERM), and other agencies. These ongoing-studies will provide baseline data relating salinity and ecological conditions with hydrologic change. Variations in salinity, conductivity, dissolved oxygen, ph, and temperature will continue to be monitored.

7. **East of the L-31N Canal.** Groundwater wells east of the L-31N Canal will be monitored to measure impacts on private lands east of the canal.

Annual Reporting

A key part of the ecological assessments for Test 7 involves the analysis of spatial water levels, water depth, hydroperiod, and seasonal rainfall data. The collection and dissemination of this data will be provided to the ecological monitoring group by the hydrological monitoring group in accordance with the schedule shown in Table 2. In addition, the hydrological monitoring group will perform an annual operational evaluation of Test 7 and prepare a joint annual monitoring report.

Funding

Funding for the monitoring plan will depend upon agency appropriations and recommendations of the hydrologic and ecological monitoring groups.

Data Exchange

The exchange of hydrologic data will be in accordance with the format agreed upon by the IDCT working group. This group consists of members from the Everglades National Park (NPS-ENP), the SFWMD Operation Division and Data Management Division, the U. S. Geological Survey in Miami (USGS), and the U.S. Army Corps of Engineers Water Management and Meteorology Section (Corps). A generalized Data Exchange Format was developed from a modified .E format of Standard Hydrologic Exchange Format (SHEF).

Table 2. Monitoring Schedule

DATE	ACTION
November 1, 1995	Initiate monitoring (where possible)
January 31, 1996	Finalize ecological needs for hydrology data
October 31, 1996	Complete 1st year of data collection
January 31, 1997	Hydrological data outputs due
March 31, 1997	Annual hydrological and ecological assessments/reports due
October 31, 1997	Complete 2nd year of data collection
January 31, 1998	Hydrological data outputs due
March 31, 1998	Annual hydrological and ecological assessments/reports due
October 31, 1998	Complete 3rd year of data collection
January 31, 1999	Hydrological data outputs due
March 31, 1999	Annual hydrological and ecological assessments/reports due
October 31, 1999	Complete data collection
January 31, 2000	Final hydrological data outputs due
March 31, 2000	Final ecological and hydrological assessments/reports due
May 1, 2000	Decision on changes to program